

Is Inflation Just Around the Corner?

The Phillips Curve and Global Inflationary Pressures

By Olivier Coibion, Yuriy Gorodnichenko, and Mauricio Ulate*

* Coibion: Department of Economics, University of Texas, 2225 Speedway, BRB 1.116, C3100, Austin, Texas 78712, (ocoibion@austin.utexas.edu); Gorodnichenko: Department of Economics, 530 Evans Hall #3880, University of California, Berkeley, CA 94720-3880 (ygorodni@econ.berkeley.edu); Ulate: Department of Economics, 530 Evans Hall #3880, University of California, Berkeley, CA 94720-3880 (mauricioulate@econ.berkeley.edu); We are very grateful to Mathieu Pedemonte for excellent assistance with the data, Geoff Kenny and Aidan Meyler for providing data on Euro-zone expectations, and our discussant Kirstin Hubrich for helpful comments.

Ten years after the start of the Great Recession and in the midst of one of the longest U.S. expansions on record, concern is gradually turning to rising inflation. This is not limited to the U.S.: a growing chorus suggests that output gaps have finally closed for most advanced economies and that inflationary pressures may already be building (e.g., World Bank 2018). Figure 1 below shows that, from the lows of the mid-2010s, inflation has slowly risen both in the U.S. and across the world. Is inflation just around the corner?

[Insert Figure 1 Here]

The link between inflation and the level of economic activity is generally characterized through a Phillips curve, and increasingly through the type of expectations-augmented Phillips curve suggested by modern macroeconomic models (see Coibion, Gorodnichenko and Kamdar 2018 for a

review). Establishing this link between inflation and the real side of the economy, however, hinges on being able to measure inflation expectations of price-setters: traditional backward-looking Phillips curves yield no systematic relationship between inflation and economic slack.

Few countries have long-running surveys of inflation expectations. As a result, it is not generally feasible to estimate country-specific expectations-augmented Phillips curves in the same way as can be done for the U.S. (e.g. Coibion and Gorodnichenko 2015, Binder 2015). But by pooling across a range of countries who have consumer or firm surveys available for shorter periods, we are able to document a robust and negative relationship between the inflation gap (the deviation of inflation from expected inflation) and the unemployment gap (the deviation of unemployment from the natural rate). The robustness of this relationship across countries confirms a fundamental theoretical prediction of modern macroeconomic models (e.g. Woodford 2003, Clarida, Gali and Gertler 1999).

An expectations-augmented Phillips curve provides a useful real-time metric for assessing the degree of economic slack: when inflation is well-below inflation expectations, it is unlikely that unemployment is below the natural rate given the historical experience. Using our novel data set of inflation expectations, we estimate the global inflation gap: the common component of the deviation of inflation from inflation expectations across advanced economies. We find that this gap has risen gradually since its low in the mid-2010s, but remains negative, as in the U.S. This suggests that there remains economic slack not just in the U.S. but across most advanced economies. In short, while output gaps are likely closing given that the gap between inflation and inflation expectations is shrinking, we find no evidence that inflation is on the brink of surging ahead.

I. Cross-Country Inflation Expectations

We begin by compiling historical inflation expectations of households and firms across a wide range of countries. To understand inflation, one would ideally prefer the inflation expectations of firms, who are the price-setters. However, in most countries, such data are unavailable and surveys of expectations are commonly available only for households and professional forecasters (Coibion,

Gorodnichenko, Kumar and Pedemonte 2018 provides an overview of available surveys of firms' inflation expectations). Coibion and Gorodnichenko (2015), Binder (2015), and Pfajar and Roberts (2018) provide evidence that the inflation expectations of firms are best proxied through those of households rather than professional forecasters. We follow this approach and focus on inflation expectations of firms and households (if a survey of firms is not available) across a range of countries.

We assemble time series of inflation expectations for 18 countries/regions (Australia, Canada, Chile, Czechia, Denmark, Finland, France, Germany, Israel, Italy, Japan, New Zealand, South Korea, Sweden, Turkey, United Kingdom, United States, as well as the entire Euro zone) over different periods (see Appendix Table 1 for details). Most countries have surveys that become available around 2000. Consistent with the structure of the New Keynesian Phillips curve, we rely on one-year-ahead inflation expectations. Appendix Figure 4 shows historical time series of inflation expectations across countries. There is a striking amount of comovement in expectations across countries, in particular during episodes of large swings in commodity prices. This is consistent with the sensitivity of inflation expectations of households and firms to commodity, and particularly energy, price

movements (e.g., Coibion and Gorodnichenko 2015). In addition, there is a common decline in inflation expectations from 2011 to 2015, followed by a gradual increase thereafter. The Euro-zone stands out for having experienced unusually high inflation expectations from 2004 to 2009. Arioli et al. (2017) show that this is driven largely by very high inflation expectations in Spain, Italy and Portugal following the adoption of the Euro, but country-specific estimates of inflation expectations for all countries within the Euro-zone are not yet readily available.

II. Expectations-Augmented Phillips Curves across Countries

Coibion and Gorodnichenko (2015) document that, when one conditions on the inflation expectations of households, an expectations-augmented Phillips curve for the U.S. provides a stable description of the link between the nominal and the real sides of the economy, resolving in particular the puzzle of the “Missing Disinflation” during the Great Recession.

While time series of expectations are not generally long enough to replicate this analysis

¹ We also linearly detrend variables for select countries with histories of recent disinflations (Czechia, Turkey, Chile, Israel) or major changes in unemployment insurance (Germany).

for individual countries, the available expectations data suggest that this argument successfully extends beyond the U.S.. Using our cross-country data, we plot pooled estimates of the inflation gap on the vertical axis versus the unemployment gap on the horizontal axis (Figure 2). Unemployment gaps are as measured by the Organization for Economic Cooperation and Development (OECD 2018); the methodology is described in Guichard and Rusticelli (2011). As discussed in Coibion, Gorodnichenko and Ulate (2018), the OECD approach (like that of other official sources) to estimating the equilibrium unemployment rate (or potential output) is well approximated with moving averages of actual unemployment (actual output). To ensure comparability across countries, we demean both inflation and unemployment gaps for each individual country.¹

[Insert Figure 2 Here]

The relationship between inflation and unemployment gaps, pooled across countries and periods, is very strong. The slope of the relationship is -0.37 (standard error 0.07), a value which changes little when we restrict our attention to advanced economies (slope of -0.34 with standard error 0.06).²

² Despite the short samples, almost every country displays a clear negative relationship between inflation gaps and unemployment gaps. One of only two exceptions is Australia, for whom only five years of data (2014-18) is available. The other is Germany, largely due to the

Central to the strength of this Phillips curve relationship is the use of actual inflation expectations. As shown in Appendix Figure 1, there is no discernible relationship between the change in inflation and unemployment gaps. In other words, the so-called backward-looking or accelerationist Phillips curve is not successful in linking inflation and economic tightness. This stands in sharp contrast to the ability of the expectations-augmented Phillips curve to match the data across a wide range of countries.

III. Global Inflation Gap

The strength of the relationship between inflation gaps and unemployment gaps supports the interpretation of the expectations-augmented Phillips curve as a structural relationship. It can also be used to make inferences about the unemployment gap using the inflation gap when the measurement of the former is contentious. This has recently been the case in the U.S., for example, because of the dramatic decline in labor force participation since the Great Recession. These declines make current unemployment rates a potentially questionable metric of the state of labor utilization (e.g. Coibion, Gorodnichenko and Ulate 2018) while employment-to-population

ratios point toward continued slack in the labor market. As illustrated in Appendix Figure 5, changes in employment-to-population ratios in many other countries are broadly similar: there have been pronounced declines in the share of working age adults working after the Great Recession that have not yet been reversed. Despite this apparent unused labor, organizations like the World Bank estimate that advanced economies are producing at capacity.

Assuming the expectations-augmented Phillips curve is a correct representation of the relationship between the inflation gap and the degree of economic slack, we can look at the inflation gap to make inferences about how much economic slack remains in the U.S. and other countries. For the former, we plot the difference between inflation and inflation expectations directly in Figure 3. For the latter, we estimate a global inflation gap that pools information across different countries. Specifically, we regress country-specific gaps on country fixed effects and time dummies. We then interpret the coefficients on time dummies as the global inflation gap (after normalizing their level to be zero on average during 2000-2007). The resulting estimate of the global inflation gap is also plotted in Figure 3.

Hartz reform which was followed by a long secular decline in unemployment. Appendix Figure 6 shows the scatterplots of raw inflation and unemployment gaps for each country separately.

[Insert Figure 3 Here]

The U.S. and global inflation gap display qualitatively similar dynamics. Both were steady around zero through much of the 2000s but fell with the onset of the Great Recession, consistent with global declines in economic activity at the time. These gaps experienced further declines from 2011 to 2014 as economic weakness remained pronounced or increased further depending on the country. Since then however, both the U.S. and global inflation gap have been shrinking. By mid 2018, we estimate a global inflation gap of approximately -0.3% below the average levels from the 2000s, implying that unemployment remains above natural rates of unemployment globally. To get a sense of the implied magnitude of the unemployment gap, we use the estimated slope of the Phillips curve shown in Figure 2. This yields an estimate of the implied unemployment gap of approximately one percentage point, although there remains considerable sampling uncertainty in this estimate. This positive gap supports the notion that some economic slack remains and that inflation is unlikely to surge anytime soon in the absence of a rapid rise in inflation expectations or significant further declines in unemployment.

IV. Conclusion

The length of the recovery since the Great Recession and the low reported levels of the unemployment rate in the U.S. are increasingly generating concerns about inflationary pressures. We document that an expectations-augmented Phillips curve can account for inflation not just in the U.S. but across a range of countries, once household or firm-level inflation expectations are used. Given this relationship, we can infer the dynamics of slack from the dynamics of inflation gaps and vice versa. We find that the implied slack was pushing inflation below expectations in the years after the Great Recession but the global and U.S. inflation gaps have shrunk in recent years thus suggesting tighter economic conditions. While we find no evidence that inflation is on the brink of rising, the sustained deflationary pressures following the Great Recession have abated.

REFERENCES

Arioli, Rodolfo, Colm Bates, Heinz Dieden, Ioana Duca, Roberta Friz, Christian Gayer, Geoff Kenny, Aidan Meyler, and Iskra Pavlova. 2017. "EU Consumers' Quantitative Inflation Perceptions and Expectations: An Evaluation," ECB Occasional Working Paper Series No. 186.

- Binder, Carola. 2015. "Whose expectations augment the Phillips curve?" *Economics Letters* 136(C), 35-38.
- Clarida, Richard, Jordi Gali, and Mark Gertler. 1999. "The Science of Monetary Policy: A New Keynesian Perspective." *Journal of Economic Literature* 37 (4): 1661-1707.
- Coibion, Olivier and Yuriy Gorodnichenko. 2015. "Is the Phillips Curve Alive and Well After All? Inflation Expectations and the Missing Disinflation," *AEJ Macroeconomics* 7(1), 197-232.
- Coibion, Olivier, Yuriy Gorodnichenko and Mauricio Ulate. 2018. "The Cyclical Sensitivity in Estimates of Potential Output," Forthcoming in *Brookings Papers on Economic Activity* (Fall 2018).
- Coibion, Olivier, Yuriy Gorodnichenko and Rupal Kamdar. 2018. "The Cyclical Sensitivity in Estimates of Potential Output," Forthcoming in *Brookings Papers on Economic Activity* (Fall 2018).
- Coibion, Olivier, Yuriy Gorodnichenko, and Rupal Kamdar. 2018. "The Formation of Expectations, Inflation, and the Phillips Curve." *Journal of Economic Literature* 56(4): 1447-1491.
- Guichard, Stéphanie, and Elena Rusticelli. 2011. "Reassessing the NAIRUs after the Crisis," OECD Economics Department Working Papers 918, OECD Publishing.
- Organization for Economic Cooperation and Development, 2018. *Economic Outlook May 2018*. Available at <http://www.oecd.org/eco/outlook/economic-outlook-may-2018/>.
- Pfajfar, Damjan, and John M. Roberts, 2018. "The Role of Expectations in Changed Inflation Dynamics," *Finance and Economics Discussion Series* 2018-062, Board of Governors of the Federal Reserve System.
- Woodford, Michael. 2003. *Interest and Prices*. Princeton University Press.
- World Bank, 2018. "Is the global economy turning the corner?" *Global Economic Prospects*, Jan. 2018, 8-12.

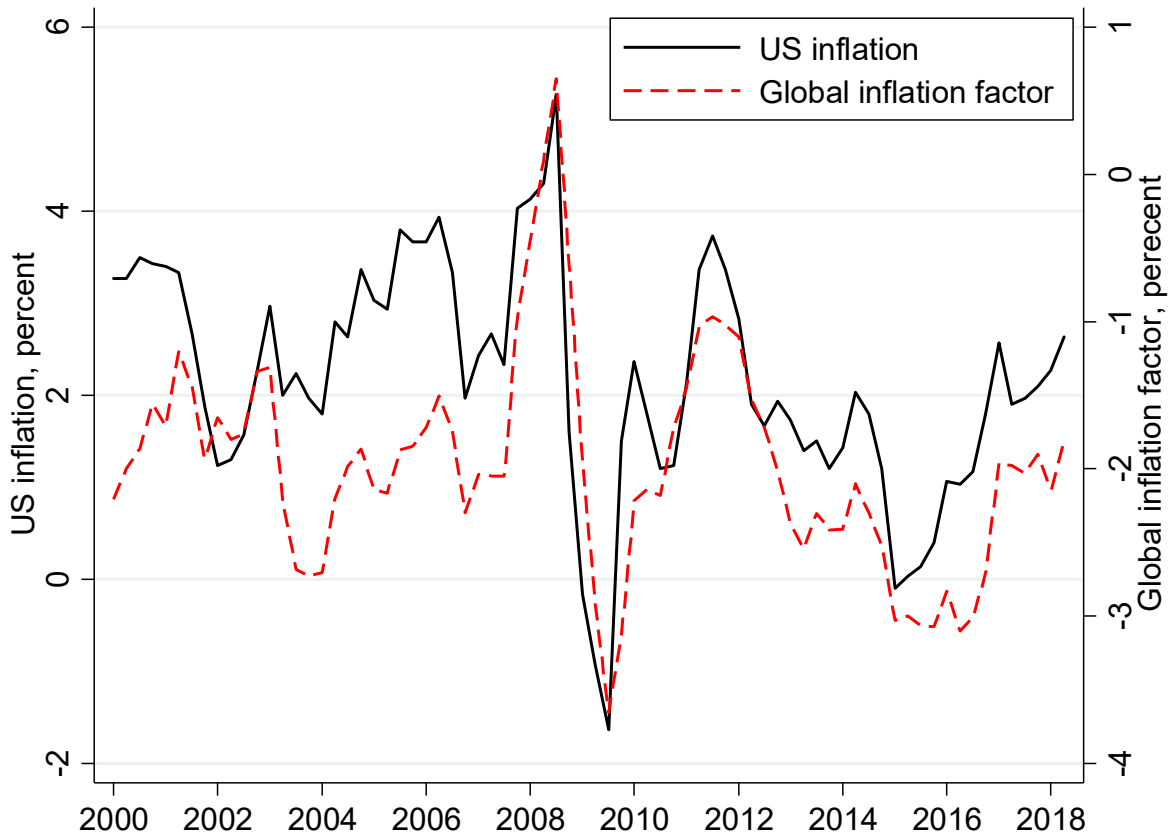


FIGURE 1. U.S. INFLATION AND GLOBAL INFLATION

Note: The figure plots time series of the U.S. annual CPI inflation and the global inflation factor. The global inflation factor is measured as the time fixed effects λ_t in the following regression: $\pi_{it} = \alpha_i + \lambda_t + error_{it}$ where i and t index countries and time. In this regression, we include country specific linear time trends for select countries with histories of recent disinflations (Czechia, Turkey, Chile, Israel) or major changes in unemployment insurance (Germany). The global inflation factor is scaled to have zero mean.

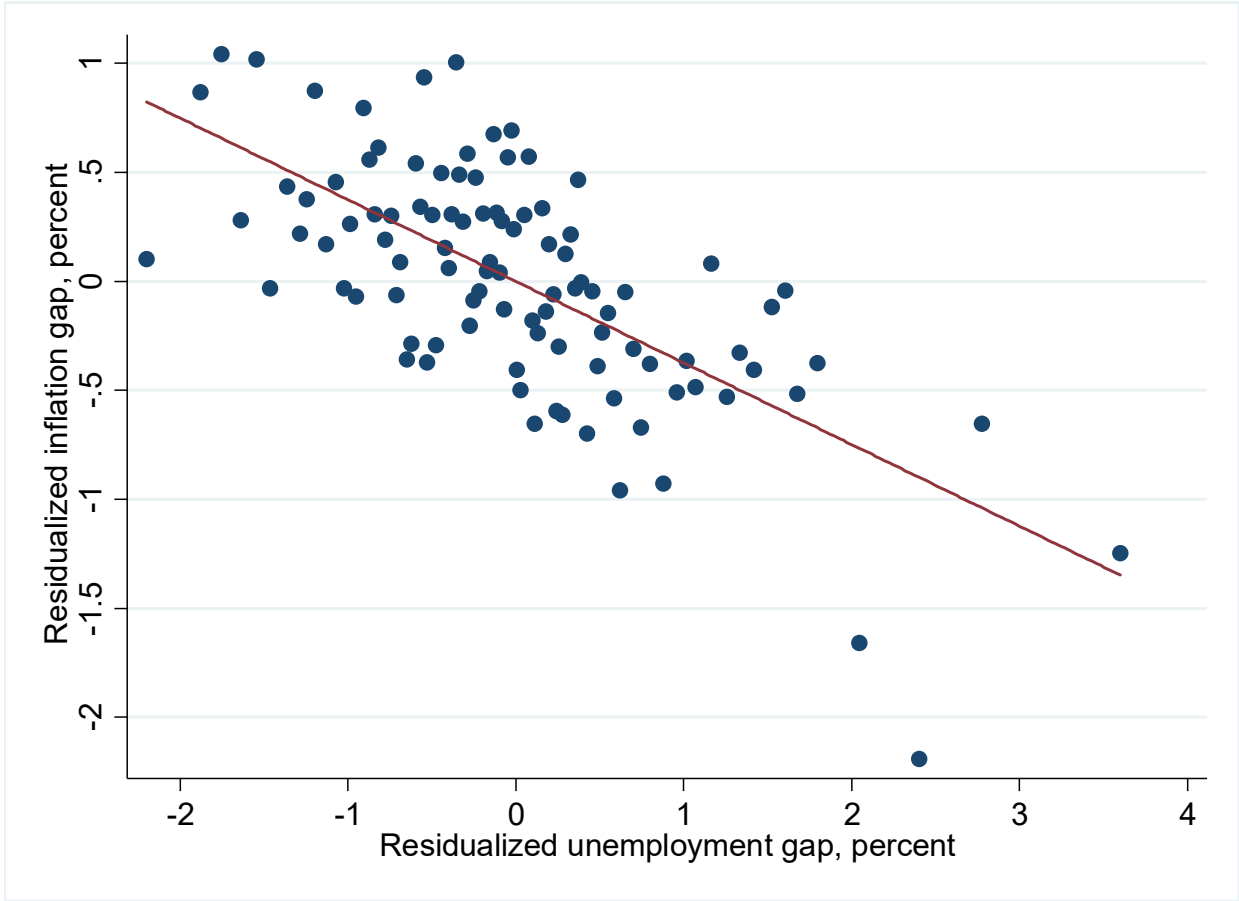


FIGURE 2. THE EXPECTATIONS-AUGMENTED PC ACROSS COUNTRIES

Note: The figure presents a binscatter plot (100 bins) of inflation gap ($\pi_{it} - E_t \pi_{i,t+1}$) versus unemployment gap ($u_{it} - u_{it}^*$) where i and t index countries and time, π_{it} is year-on-year CPI inflation rate, $E_t \pi_{i,t+1}$ is one-year-ahead inflation expectations of households or firms, u_{it} is unemployment rate, u_{it}^* is non-accelerating inflation rate of unemployment rate (NAIRU) provided by the OECD. We residualize inflation gap and unemployment gap, i.e., we remove country fixed effects (and country-specific linear time trends for Czechia, Chile, Turkey, Israel and Germany). The scatter plot for raw data is provided in Appendix Figure 1.

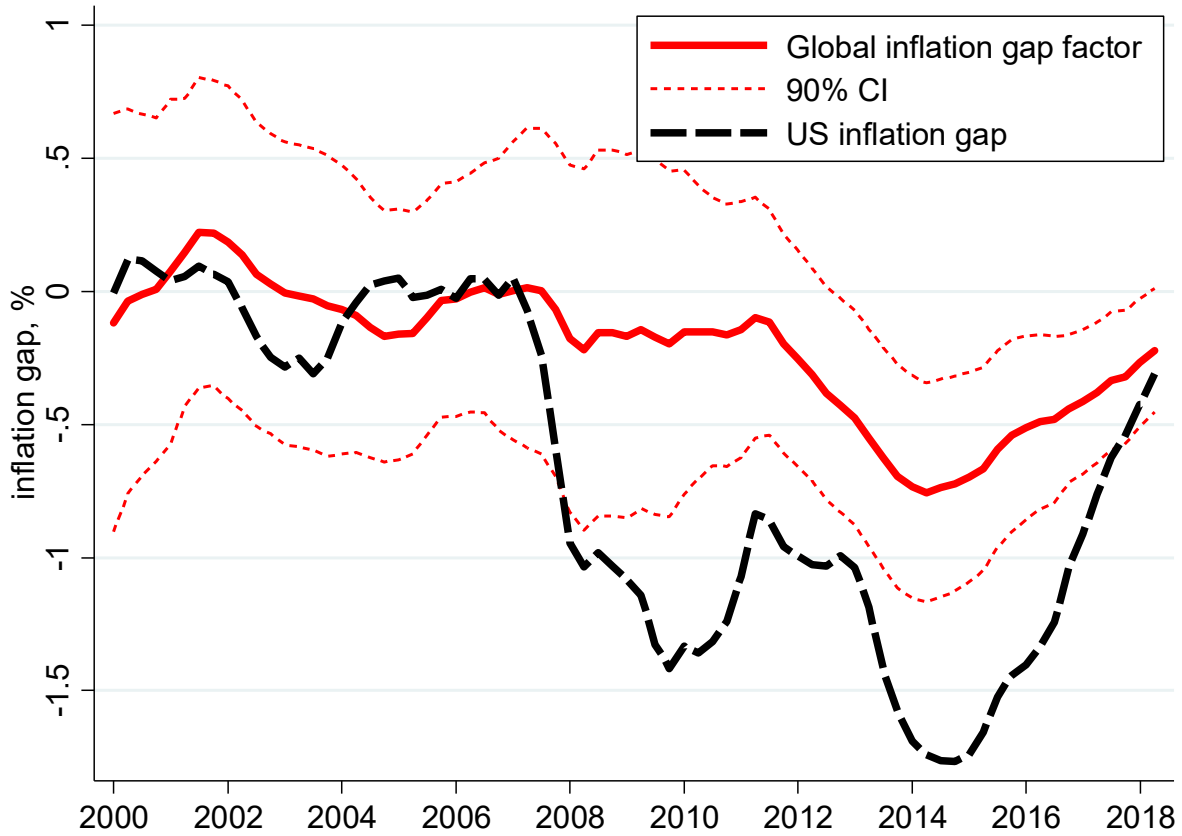


FIGURE 3. THE GLOBAL AND U.S. INFLATION GAP

Note: The figure plots time series of inflation gap, i.e. the different between actual inflation and one-year-ahead inflation expectations of households or firms. The global inflation gap is measured as the time fixed effects λ_t in the following regression: $\pi_{it} - E_t\pi_{i,t+1} = \alpha_i + \lambda_t + error_{it}$ where i and t index countries and time. In this regression, we include country specific linear time trends for select countries with histories of recent disinflations (Czechia, Turkey, Chile, Israel) or major changes in unemployment insurance (Germany). The global inflation factor and the U.S. inflation gap are scaled to have zero mean over the 2000-2007 period. The time series are smoothed using one-year moving averages. Unsmoothed series are reported in Appendix Figure 3.

Online Appendix

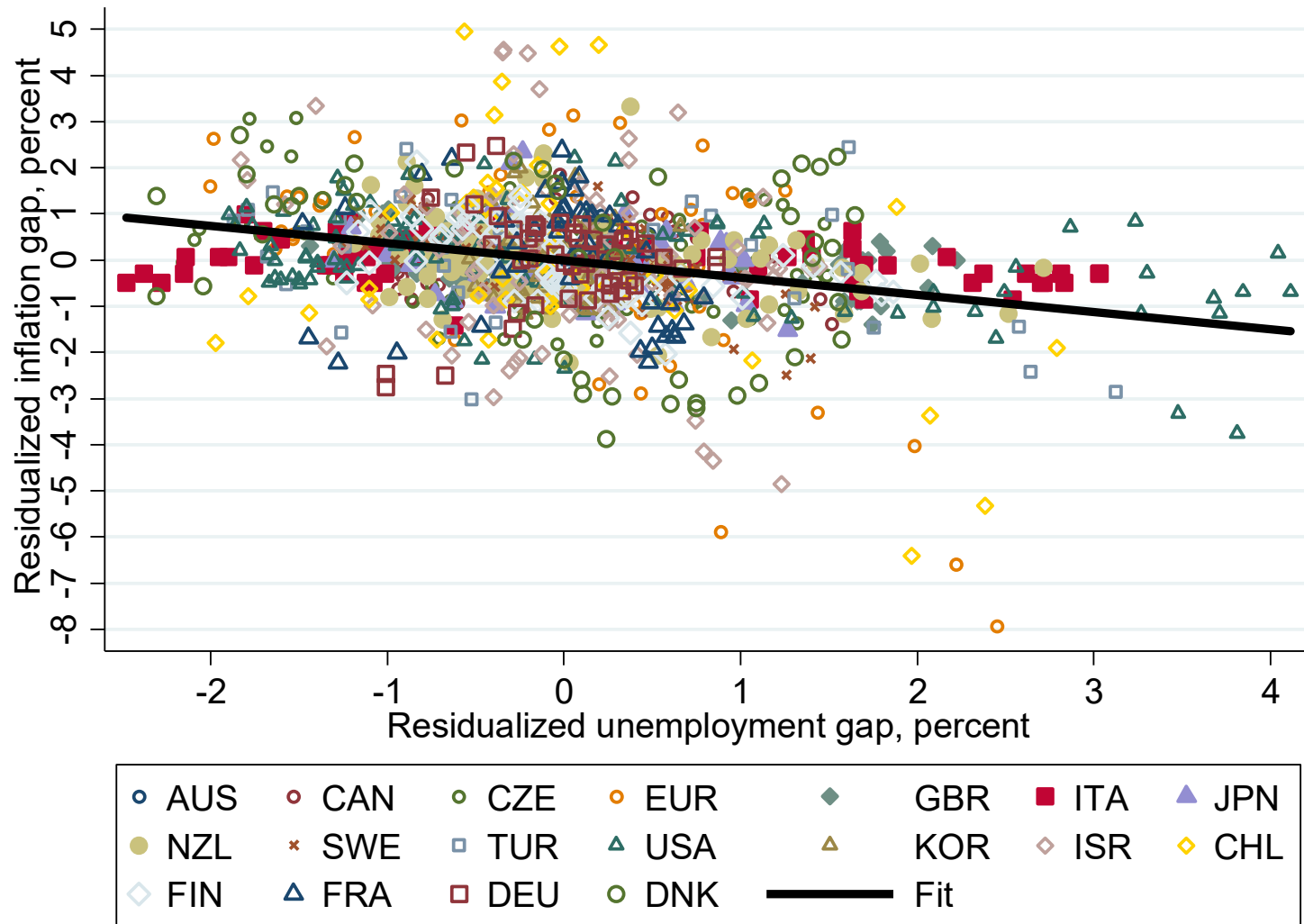
APPENDIX TABLE 1. SOURCES OF INFLATION EXPECTATIONS

Country	Country code	Survey	Respondent	Coverage
USA	USA	Michigan Survey of Consumers	Consumers	1978-2018
Australia	AUS	Melbourne Institute, Survey of Consumer Inflationary Expectations	Consumers	2014-2018
Canada	CAN	Bank of Canada, Business Outlook Survey	Firms	2001-2018
Czechia	CZE	Czech National Bank, Statistical Survey	Firms	1999-2018
United Kingdom	GBR	Bank of England/TNS, Inflation Attitudes Survey	Consumers	1999-2018
Eurozone	EUR	European Commission	Consumers	2004-2016
France	FRA	European Commission	Consumers	2004-2015
Germany	DEU	European Commission	Consumers	2004-2015
Denmark	DNK	European Commission	Consumers	2004-2015
Italy	ITA	Bank of Italy, Survey of Households and Firms	Firms	2000-2018
Japan	JPN	Cabinet Office, Consumer Confidence Survey	Consumers	2004-2018
Korea	KOR	Bank of Korea, Survey of Consumer Expectations	Consumers	2002-2018
New Zealand	NZL	Reserve Bank of New Zealand, Survey of Expectations	Consumers	1987-2018
Sweden	SWE	National Institute of Economic Research, Economic Tendency Survey	Consumers	2001-2018
Turkey	TUR	Turkish Central Bank, Business Tendency Statistics	Firms	2007-2018
Israel	ISR	Bank of Israel Companies Survey	Firms	1996-2018
Finland	FIN	Bank of Finland/European Commission	Consumers	2000-2018
Chile	CHL	University of Chile, Survey of Perception and Expectations about the Economic Situation	Consumers	2005-2018

Notes: Data for the Eurozone, France, Germany, and Denmark are taken from Arioli et al. (2018). The time series of inflation expectations for Italy is adjusted for the fact that in the early part of the survey firms were provided with recent inflation expectations which strongly influences inflation expectations (see. Coibion et al. 2018 for more details). In the later part of the survey, a subset of firms is not provided with recent inflation. We find that inflation gap for firms that are not provided with recent inflation is 1.8 times larger than inflation gap for firms that are provided with recent inflation. Hence, we multiply the time series of the inflation gap by 1.8.

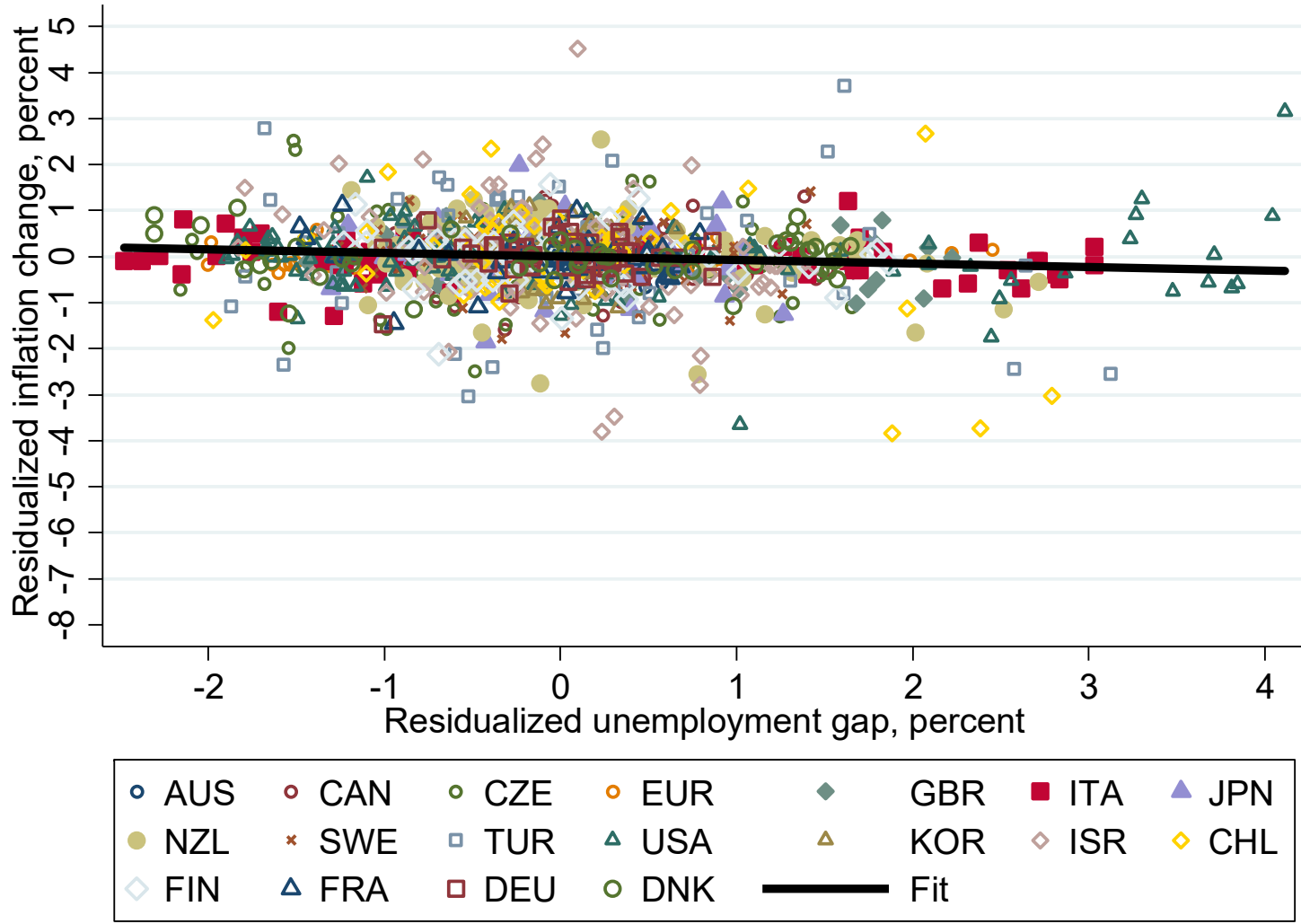
Coibion, Olivier, Yuriy Gorodnichenko and Tiziano Ropele. 2018. "Inflation Expectations and Firm Decisions: New Causal Evidence," Manuscript.

APPENDIX FIGURE 1. THE EXPECTATIONS-AUGMENTED PHILLIPS CURVE ACROSS COUNTRIES.



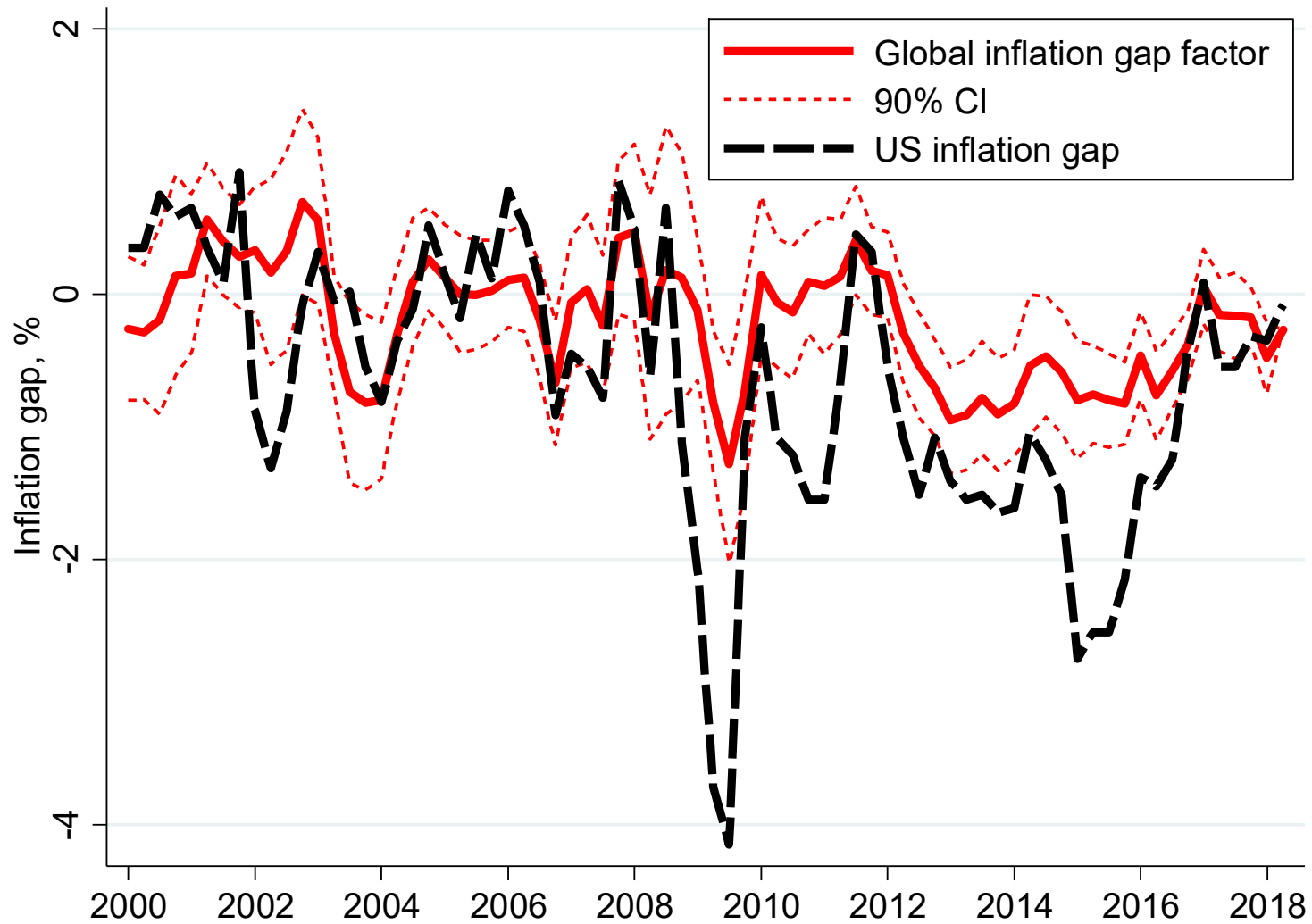
Note: The figure presents a scatter plot of inflation gap ($\pi_{it} - E_t\pi_{i,t+1}$) versus unemployment gap ($u_{it} - u_{it}^*$) where i and t index countries and time (quarter), π_{it} is year-on-year CPI inflation rate, $E_t\pi_{it}$ is one-year-ahead inflation expectations of households or firms, u_{it} is unemployment rate, u_{it}^* is non-accelerating inflation rate of unemployment rate (NAIRU) provided by the OECD. We residualize inflation gap and unemployment gap, i.e., we remove country fixed effects (and country-specific linear time trends for Czech Rep., Chile, Turkey, Israel and the Euro zone).

APPENDIX FIGURE 2. THE BACKWARD-LOOKING PHILLIPS CURVE ACROSS COUNTRIES.



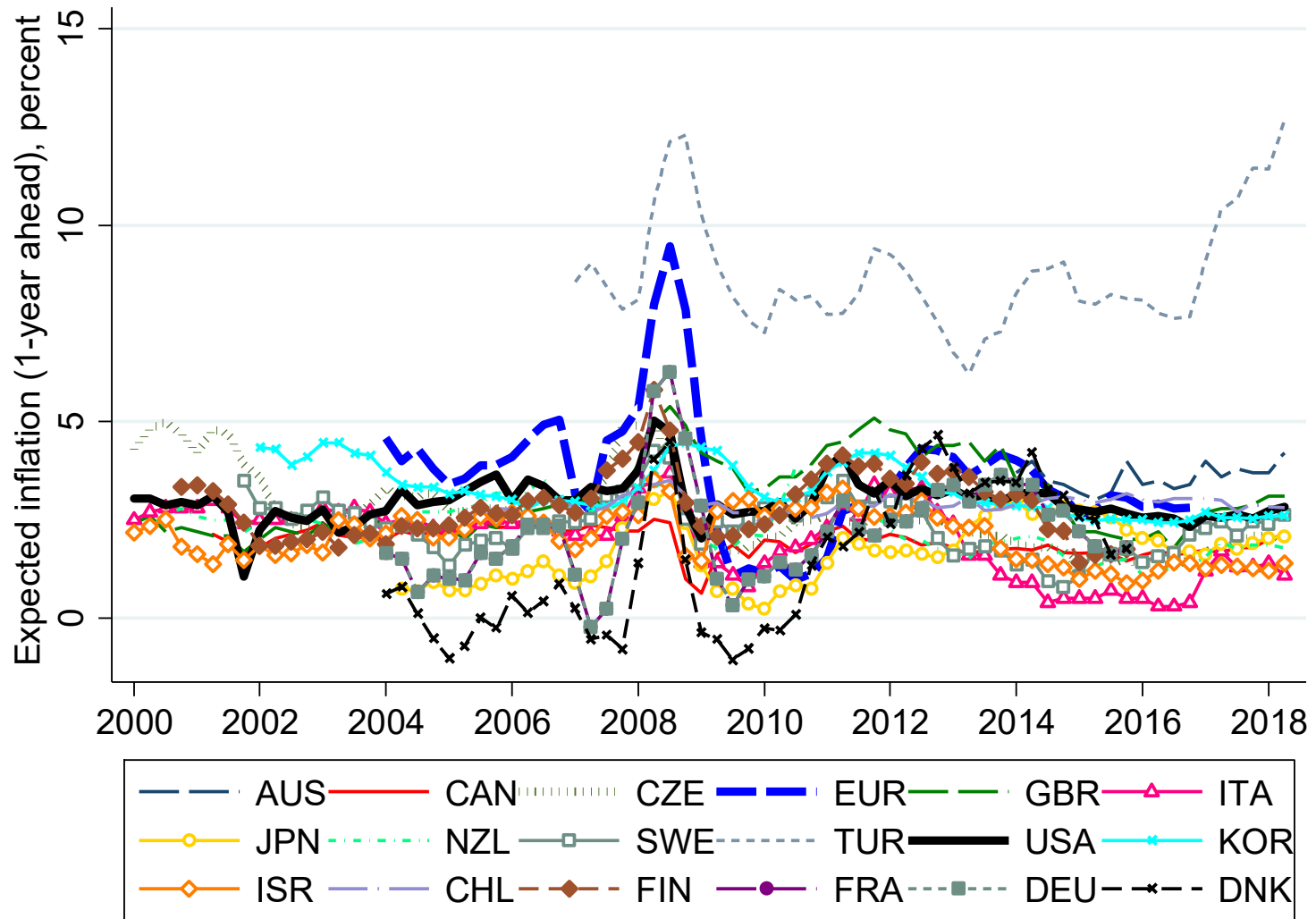
Note: The figure presents a scatter plot of inflation change ($\pi_{it} - \pi_{i,t-1}$) versus unemployment gap ($u_{it} - u_{it}^*$) where i and t index countries and time (quarter), π_{it} is year-on-year CPI inflation rate, u_{it} is unemployment rate, u_{it}^* is non-accelerating inflation rate of unemployment rate (NAIRU) provided by the OECD. We residualize inflation gap and unemployment gap, i.e., we remove country fixed effects (and country-specific linear time trends for Czechia, Chile, Turkey, Israel and the Euro zone).

APPENDIX FIGURE 3. THE GLOBAL AND U.S. INFLATION GAP



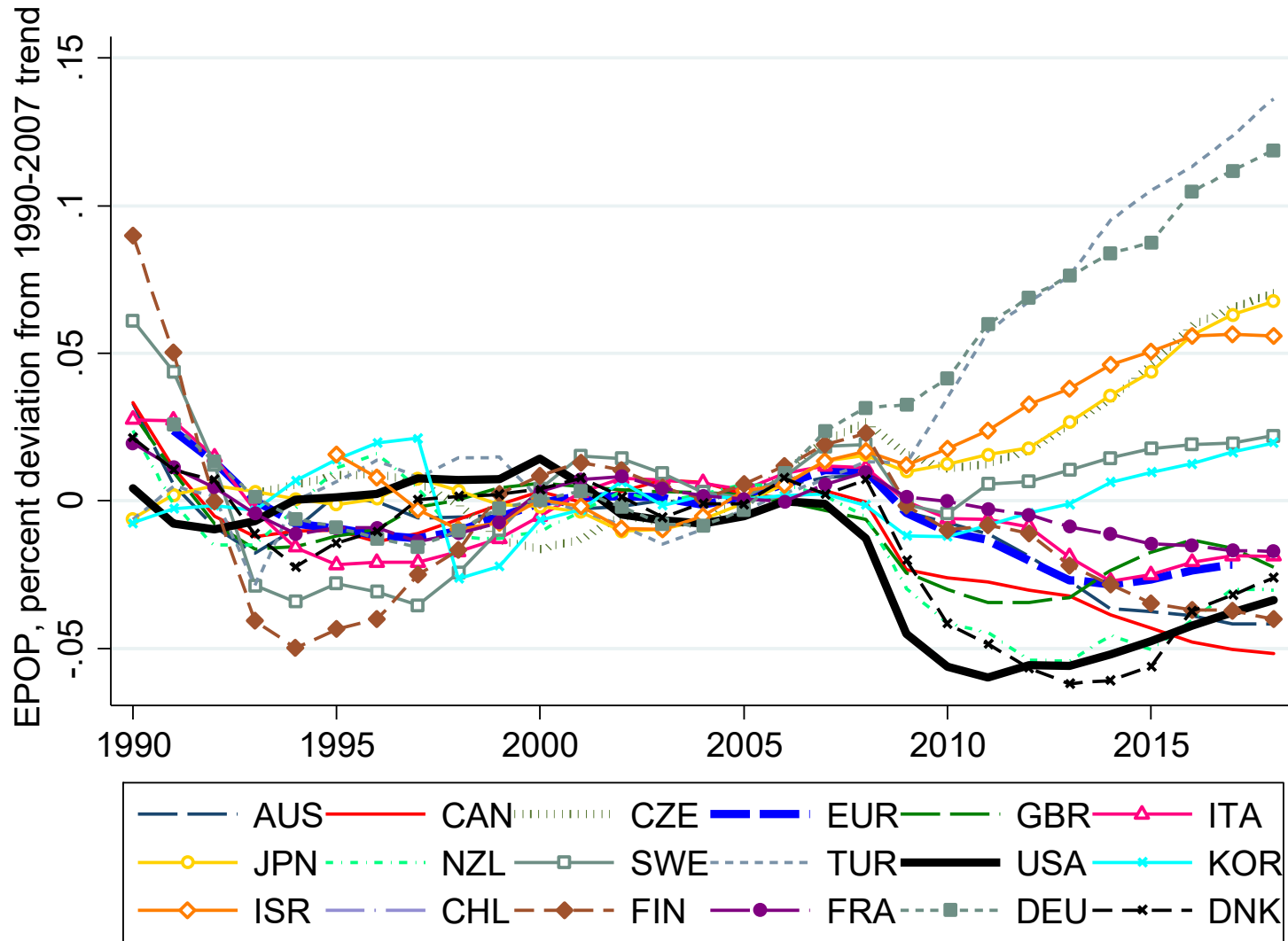
Note: The figure plots time series of inflation gap, i.e. the different between actual inflation and one-year-ahead inflation expectations of households or firms. The global inflation gap is measured as the time fixed effects λ_t in the following regression: $\pi_{it} - E_t\pi_{i,t+1} = \alpha_i + \lambda_t + error_{it}$ where i and t index countries and time. In this regression, we include country specific linear time trends for select countries with histories of recent disinflations (Czechia, Turkey, Chile, Israel) or major monetary changes (the Euro zone). The global inflation factor and the U.S. inflation gap are scaled to have zero mean over the 2000-2007 period. The time series are smoothed using one-year moving averages.

APPENDIX FIGURE 4. INFLATION EXPECTATIONS



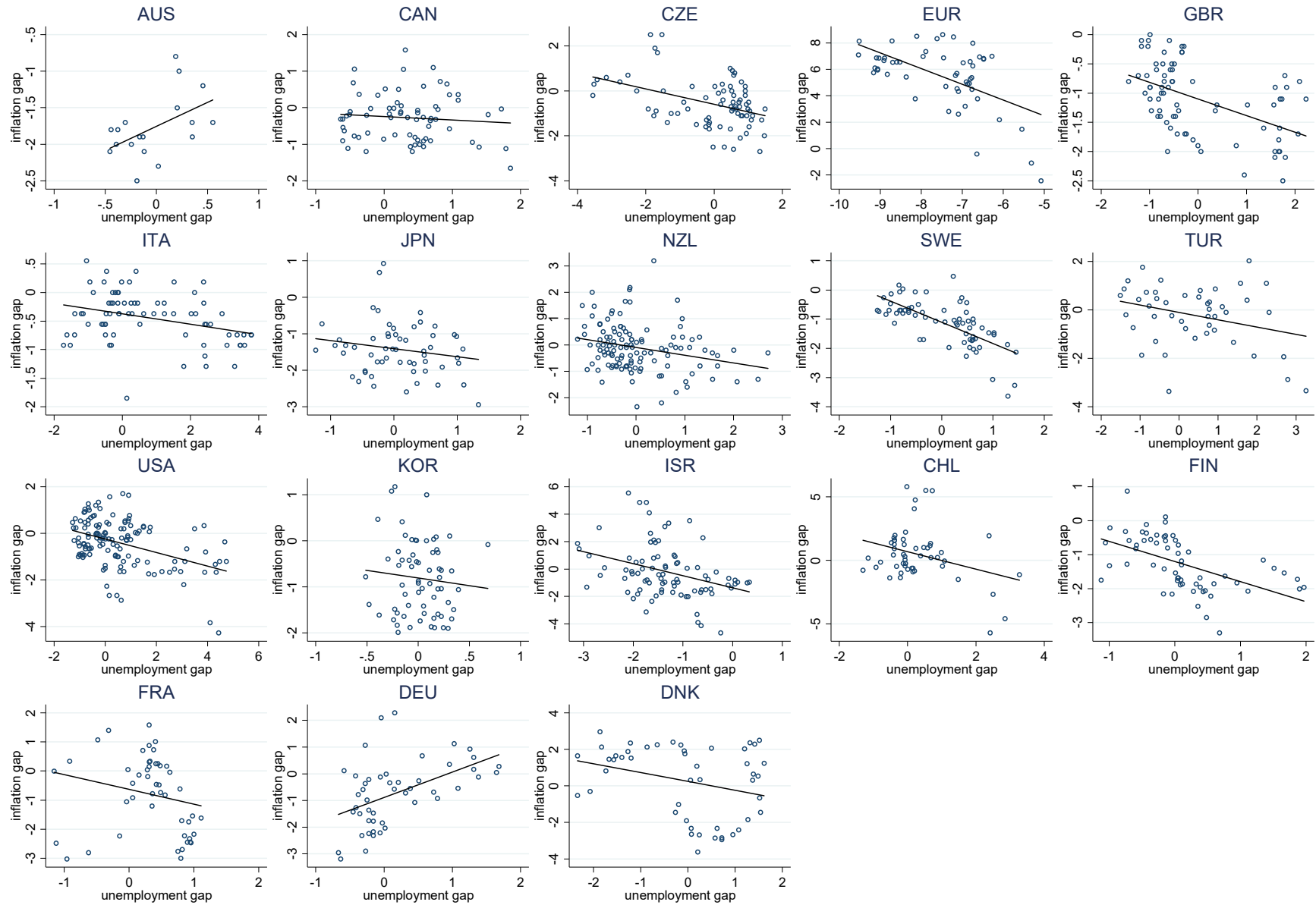
Note: The figure plots time series of inflation expectations for households or firms since 2000. The sources of expectations are reported in Appendix Table 1.

APPENDIX FIGURE 5. EMPLOYMENT TO POPULATION RATIO



Notes: the figure plots detrended time series of employment-to-population ratios. For each country, a linear time trend is estimated on the 1990-2007 sample.

APPENDIX FIGURE 6. THE EXPECTATIONS-AUGMENTED PHILLIPS CURVE BY COUNTRY.



Note: The figure presents a scatter plot of inflation gap ($\pi_{it} - E_t\pi_{i,t+1}$) versus unemployment gap ($u_{it} - u_{it}^*$) where i and t index countries and time (quarter), π_{it} is year-on-year CPI inflation rate, $E_t\pi_{i,t+1}$ is one-year-ahead inflation expectations of households or firms, u_{it} is unemployment rate, u_{it}^* is non-accelerating inflation rate of unemployment rate (NAIRU) provided by the OECD.